Claims

1. A method for adjusting the atmosphere within a substantially sealed chamber containing respiring produce, the chamber having inlet means to permit ambient atmosphere to enter the chamber, and outlet means to permit chamber atmosphere to exit the chamber, the method comprising:

   (a) monitoring the oxygen concentration within the chamber;

   (b) following detection that the oxygen concentration in the chamber has fallen below a predetermined amount, opening the inlet means to admit ambient atmosphere into the chamber so that the amount of oxygen in the chamber increases; and

   (c) removing carbon dioxide from the chamber atmosphere substantially at a predetermined rate, the predetermined rate having been selected such that the carbon dioxide concentration within the chamber atmosphere does not substantially exceed a predetermined amount.

2. ~~A method according to claim 1 wherein at least part of said carbon dioxide removal is effected by contacting a quantity of carbon dioxide absorbing material with the chamber atmosphere.~~

3. A method according to claim 1 wherein said predetermined carbon dioxide removal rate is calculated from a formula derived from a mathematical model of the proportions of the chamber atmosphere subject to the requirement that the oxygen concentration within the chamber be substantially maintained at a predetermined amount.

4. ~~A method according to claim 2 wherein said predetermined carbon dioxide removal rate is calculated from a formula derived from a mathematical model of the proportions of the chamber atmosphere subject to the requirement that the oxygen concentration within the chamber be substantially maintained at a predetermined amount.~~

5. A method according to claim 3 wherein said predetermined carbon dioxide removal rate is calculated from a formula that produces a result substantially equal to the result produced by a calculation in accordance with the following formula:

$$a_{CO_2} = r_{CO_2} - \frac{0.79 p_{CO_2} r_{O_2}}{(0.21 - p_{O_2}) - 0.21 p_{CO_2}}$$

where a_{O_2} is the carbon dioxide removal rate; p_{O_2} is the oxygen setpoint, expressed as a proportion; p_{CO_2} is the desired carbon dioxide concentration within the chamber, expressed as a proportion; r_{O_2} is the respiration rate; and r_{CO_2} is the rate of production of carbon dioxide through respiration.

6. A method according to claim 4 wherein said predetermined carbon dioxide removal rate is calculated from a formula that produces a result substantially equal to the result produced by a calculation in accordance with the following formula:

$$a_{CO_2} = r_{CO_2} - \frac{0.79 p_{CO_2} r_{O_2}}{(0.21 - p_{O_2}) - 0.21 p_{CO_2}}$$

where a_{O_2} is the carbon dioxide removal rate; p_{O_2} is the oxygen setpoint, expressed as a proportion; p_{CO_2} is the desired carbon dioxide concentration within the chamber, expressed as a proportion; r_{O_2} is the respiration rate; and r_{CO_2} is the rate of production of carbon dioxide through respiration.

7. A method according to claim 2 wherein said carbon dioxide absorbing material is contained in at least one carbon dioxide transmissible container.

8. A method according to claim 4 wherein said carbon dioxide absorbing material is contained in at least one carbon dioxide transmissible container.

9. A method according to claim 6 wherein said carbon dioxide absorbing material is contained in at least one carbon dioxide transmissible container.

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~~10.~~ ~~A method~~ according to claim 7 wherein said at least one carbon dioxide transmissible container ~~is selected~~ so that the rate of carbon dioxide transmission

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into said at least one carbon dioxide transmissible container is substantially equal to said predetermined carbon dioxide removal rate.

11. A method according to claim 8 wherein said at least one carbon dioxide transmissible container is selected so that the rate of carbon dioxide transmission into said at least one carbon dioxide transmissible container is substantially equal to said predetermined carbon dioxide removal rate.

12. A method according to claim 9 wherein said at least one carbon dioxide transmissible container is selected so that the rate of carbon dioxide transmission into said at least one carbon dioxide transmissible container is substantially equal to said predetermined carbon dioxide removal rate.

13. A method according to claim 1 wherein said predetermined rate is selected on the basis of the produce to be contained in the chamber.

14. A method according to claim 2 wherein said predetermined rate is selected on the basis of the produce to be contained in the chamber.

15. A method according to claim 3 wherein said predetermined rate is selected on the basis of the produce to be contained in the chamber.

16. A method according to claim 4 wherein said predetermined rate is selected on the basis of the produce to be contained in the chamber.

17. A method according to claim 5 wherein said predetermined rate is selected on the basis of the produce to be contained in the chamber.

18. A method according to claim 6 wherein said predetermined rate is selected on the basis of the produce to be contained in the chamber.

19. A method according to claim 7 wherein said predetermined rate is selected on the basis of the produce to be contained in the chamber.

20. A method according to claim 8 wherein said predetermined rate is selected on the basis of the produce to be contained in the chamber.

21. A method according to claim 9 wherein said predetermined rate is selected on the basis of the produce to be contained in the chamber.

22. ~~A method according to claim 10 wherein said predetermined rate is selected on the basis of the produce to be contained in the chamber.~~

23. ~~A method according to claim 11 wherein said predetermined rate is selected on the basis of the produce to be contained in the chamber.~~

24. ~~A method according to claim 12 wherein said predetermined rate is selected on the basis of the produce to be contained in the chamber.~~

25. A method according to claim 1 wherein the inlet means is open for a time that is approximately proportional to the difference between the detected oxygen concentration and an oxygen setpoint.

26. A method according to claim 25 wherein, if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded a predetermined value.

27. ~~A method according to claim 26 wherein, if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint.~~

28. ~~A method according to claim 27 wherein:~~

(a) ~~if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint; and~~

(b) ~~if the difference between the detected oxygen concentration and the oxygen setpoint does not exceed the predetermined amount of step (a) then the inlet means is open for a time that depends on which of a number of predetermined ranges the said difference falls within such that the greater the average value of the range, the greater the time for which the inlet means remains open.~~

29. A method according to claim 1 wherein following said detection that the oxygen concentration in the chamber has fallen below said predetermined amount, the inlet means is opened for one or more respective lengths of time so that the amount of oxygen in the chamber increases.

30. A method according to claim 1 wherein following said detection that the oxygen concentration in the chamber has fallen below said predetermined amount, the outlet means is opened so that chamber atmosphere exits the chamber, so that when the inlet means is opened, the pressure drop in the chamber due to due to the loss of chamber atmosphere through the outlet means allows ambient air to be drawn into the chamber through the inlet means.

31. A method according to claim 1 wherein the inlet means and the outlet means are opened and closed at substantially the same time.

32. A method according to claim 1 wherein the inlet means is the outlet means.

33. A method according to claim 1 wherein the outlet means is opened to substantially maintain the pressure within the chamber at ambient pressure.

34. A method according to claim 1 further comprising the step of flushing the chamber with a gas having a low oxygen concentration, or having no oxygen, after produce has been placed in the chamber, to reduce the initial oxygen concentration in the chamber.

35. A method for adjusting the atmosphere within a substantially sealed chamber containing respiring produce, the chamber having inlet means to permit ambient atmosphere to enter the chamber, and outlet means to permit chamber atmosphere to exit the chamber, the method comprising:

(a) monitoring the oxygen concentration within the chamber;

(b) following detection that the oxygen concentration in the chamber has fallen below a predetermined amount, opening the inlet means to admit ambient atmosphere into the chamber so that the amount of oxygen in the chamber increases, the inlet means being open for a time that is approximately proportional to the difference between the detected oxygen concentration and an oxygen setpoint.

36. A method according to claim 35 wherein, if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded a predetermined value.

37. A method according to claim 36 wherein, if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint.

38. A method according to claim 37 wherein:

(a) if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint; and

(b) if the difference between the detected oxygen concentration and the oxygen setpoint does not exceed the predetermined amount of step (a) then the inlet means remains open for a time that depends on which of a number of predetermined ranges the said difference falls within such that the greater the average value of the range, the greater the time for which the inlet means remains open.

39. A method according to claim 35 wherein the outlet means is opened to substantially maintain the pressure within the chamber at ambient pressure.

40. A method according to claim 35 further comprising the step of flushing the chamber with a gas having a low oxygen concentration, or having no oxygen, after produce has been placed in the chamber, to reduce the initial oxygen concentration in the chamber.

41. A method for converting a receptacle into an adjusted atmosphere chamber for containing respiring produce comprising:

(a) forming a substantially sealed chamber in the receptacle optionally including installing sealing means so as to form said substantially sealed chamber in said receptacle;

(b) installing inlet means to permit ambient atmosphere to enter the chamber;

(c) installing outlet means to permit chamber atmosphere to exit the chamber;

(d) installing a controller having an oxygen concentration sensor and control means responsive to the oxygen concentration sensor, the control means being adapted to cause the inlet means to open to admit ambient atmosphere into the chamber following the oxygen concentration sensor detecting that the oxygen concentration in the chamber has fallen below a predetermined amount; and

(e) installing carbon dioxide removal means adapted to remove carbon dioxide from the chamber atmosphere substantially at a predetermined rate whereby the carbon dioxide concentration within the chamber atmosphere will not substantially exceed a predetermined amount when the chamber contains respiring produce.

~~42. A method according to claim 41 wherein said carbon dioxide removal means is a quantity of carbon dioxide absorbing material placed in contact with the chamber atmosphere.~~

43. A method according to claim 42 wherein said carbon dioxide absorbing material is contained in at least one carbon dioxide transmissible container.

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~~44. A method according to claim 43 wherein said at least one carbon dioxide transmissible container is selected so that the rate of carbon dioxide transmission into said at least one carbon dioxide transmissible container is substantially equal to said predetermined carbon dioxide removal rate.~~

45. A method according to claim 41 wherein said controller is adapted to cause the inlet means to remain open for a time that is approximately proportional to the difference between the detected oxygen concentration and an oxygen setpoint.

~~46. A method according to claim 42 wherein said controller is adapted to cause the inlet means to remain open for a time that is approximately proportional to the difference between the detected oxygen concentration and an oxygen setpoint.~~

47. A method according to claim 43 wherein said controller is adapted to cause the inlet means to remain open for a time that is approximately proportional to the difference between the detected oxygen concentration and an oxygen setpoint.

48. A method according to claim 44 wherein said controller is adapted to cause the inlet means to remain open for a time that is approximately proportional to the difference between the detected oxygen concentration and an oxygen setpoint.

49. A method according to claim 45 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded a predetermined value.

50. A method according to claim 46 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded a predetermined value.

51. A method according to claim 47 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded a predetermined value.

52. A method according to claim 48 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded a predetermined value.

53. A method according to claim 49 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following

detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint.

54. A method according to claim 50 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint.

55. A method according to claim 51 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint.

56. A method according to claim 52 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint.

57. A method according to claim 53 wherein said controller is so adapted that:

(a) if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint; and

(b) if the difference between the detected oxygen concentration and the oxygen setpoint does not exceed the predetermined amount in paragraph (a) then the inlet means remains open for a time that depends on which of a number of predetermined ranges the said difference falls within such that the greater the average value of the range, the greater the time for which the inlet means remains open.

58. A method according to claim 54 wherein said controller is so adapted that:

(a) if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint; and

(b) if the difference between the detected oxygen concentration and the oxygen setpoint does not exceed the predetermined amount in paragraph (a) then the inlet means remains open for a time that depends on which of a number of predetermined ranges the said difference falls within such that the greater the average value of the range, the greater the time for which the inlet means remains open.

59. A method according to claim 55 wherein said controller is so adapted that:

(a) if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint; and

(b) if the difference between the detected oxygen concentration and the oxygen setpoint does not exceed the predetermined amount in paragraph (a) then the inlet means remains open for a time that depends on which of a number of predetermined ranges the said difference falls within such that the greater the average value of the range, the greater the time for which the inlet means remains open.

60. A method according to claim 56 wherein said controller is so adapted that:

(a) if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint; and

(b) if the difference between the detected oxygen concentration and the oxygen setpoint does not exceed the predetermined amount in paragraph (a) then the inlet means remains open for a time that depends on which of a number of predetermined ranges the said difference falls within such that the greater

the average value of the range, the greater the time for which the inlet means remains open.

61. A method according to claim 41 wherein the receptacle has a door, the method including installing a substantially fluid impervious sheet in the receptacle to separate the chamber from leakage paths associated with the door.

62. A method according to claim 41 wherein said sealing means includes at least one flexible substantially fluid impervious sheet carrying inlet means and/or outlet means.

63. A method according to claim 61 wherein said sheet carries inlet means and/or outlet means.

64. A method according to claim 41 wherein the receptacle has a fan and an aperture near the high pressure side of the fan, step (a) further including installing outlet means near said aperture and near said high pressure side of the fan.

65. A method according to claim 41 wherein the receptacle has a fan and an aperture near the low pressure side of the fan, step (a) further including installing inlet means near said aperture and near said low pressure side of the fan.

66. A method according to claim 64 wherein said outlet means is carried by a substantially fluid impervious sheet, step (a) further including installing said sheet to cover said aperture near the high pressure side of said fan.

67. A method according to claim 65 wherein the inlet means is carried by a substantially fluid impervious sheet, step (a) further including installing said sheet to cover said aperture near the low pressure side of said fan.

68. A method according to claim 41 wherein the control means is further adapted to cause the outlet means to open to substantially maintain the pressure within the chamber at ambient pressure.

69. A method for converting a receptacle into an adjusted atmosphere chamber, the method comprising:

(a) forming a substantially sealed chamber in the receptacle optionally including installing sealing means so as to form said substantially sealed chamber in said receptacle;

(b) installing inlet means to permit ambient atmosphere to enter the chamber;

(c) installing outlet means to permit chamber atmosphere to exit the chamber;

(d) installing a controller having an oxygen concentration sensor and control means responsive to the oxygen concentration sensor, the control means being adapted to cause the inlet means to open to admit ambient atmosphere into the chamber following the oxygen concentration sensor detecting that the oxygen concentration in the chamber has fallen below a predetermined amount, said controller is adapted to cause the inlet means to remain open for a time that is approximately proportional to the difference between the detected oxygen concentration and the oxygen setpoint.

70. A method according to claim 69 wherein said controller is adapted to cause the inlet means to remain open for a time that is approximately proportional to the difference between the detected oxygen concentration and an oxygen setpoint.

71. A method according to claim 70 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded a predetermined value.

72. A method according to claim 71 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint.

73. A method according to claim 72 wherein said controller is so adapted that:

(a) if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open

until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint; and

(b) if the difference between the detected oxygen concentration and the oxygen setpoint does not exceed the predetermined amount in paragraph (a) then the inlet means remains open for a time that depends on which of a number of predetermined ranges the said difference falls within such that the greater the average value of the range, the greater the time for which the inlet means remains open.

74. A method according to claim 69 wherein the receptacle has a door, the method including installing a substantially fluid impervious sheet in the receptacle to separate the chamber from leakage paths associated with the door.

75. A method according to claim 69 wherein said sealing means includes at least one flexible substantially fluid impervious sheet carrying inlet means and/or outlet means.

76. A method according to claim 74 wherein said sheet carries inlet means and/or outlet means.

77. A method according to claim 69 wherein the receptacle has a fan and an aperture near the high pressure side of the fan, step (a) further including installing outlet means near said aperture and near said high pressure side of the fan.

78. A method according to claim 69 wherein the receptacle has a fan and an aperture near the low pressure side of the fan, step (a) further including installing inlet means near said aperture and near said low pressure side of the fan.

79. A method according to claim 77 wherein the outlet means is carried by a substantially fluid impervious sheet, step (a) further including installing said sheet to cover said aperture near the high pressure side of said fan.

80. A method according to claim 78 wherein the inlet means is carried by a substantially fluid impervious sheet, step (a) further including installing said sheet to cover said aperture near the low pressure side of said fan.

81. A method according to claim 69 wherein the control means is further adapted to cause the outlet means to open to substantially maintain the pressure within the chamber at ambient pressure.

82. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 41.

83. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 42.

84. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 44.

85. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 45.

86. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 49.

87. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 57.

88. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 61.

89. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 62.

90. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 63.

91. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 64.

92. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 65.

93. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 66.

94. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 67.

95. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 68.

96. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 69.

97. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 70.

98. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 71.

99. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 72.

100. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 73.

101. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 74.

102. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 75.

103. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 76.

104. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 77.

105. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 78.

106. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 79.

107. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 80.

108. A receptacle when converted into an adjusted atmosphere chamber in accordance with the method of claim 81.

109. Apparatus for adjusting the atmosphere within a chamber comprising:

(a) sealing means for substantially sealing the chamber;

(b) inlet means to permit ambient atmosphere to enter the chamber;

(c) outlet means to permit chamber atmosphere to exit the chamber; and

(d) a controller having an oxygen concentration sensor and control means responsive to the oxygen concentration sensor, the control means being adapted to cause the inlet means to open to admit ambient atmosphere into the chamber following the oxygen concentration sensor detecting that the oxygen concentration in the chamber has fallen below a predetermined amount, said controller being adapted to cause the inlet means to remain open for a time that is approximately proportional to the difference between the detected oxygen concentration and an oxygen setpoint.

110. Apparatus according to claim 109 wherein said controller is so adapted that if the difference between ~~the detected~~ oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded a predetermined value.

111. Apparatus according to claim 110 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint.

112. Apparatus according to claim 111 wherein said controller is so adapted that:

(a) if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint; and

(b) if the difference between the detected oxygen concentration and the oxygen setpoint does not exceed said predetermined amount in paragraph (a) then the inlet means remains open for a time that depends on which of a number of predetermined ranges the said difference falls within such that the greater the average value of the range, the greater the time for which the inlet means remains open.

113. Apparatus according to claim 109 wherein said sealing means includes a substantially fluid impervious sheet for separating the chamber from leakage paths associated with the door.

114. Apparatus according to claim 109 wherein said sealing means includes at least one flexible substantially fluid impervious sheet carrying inlet means and/or outlet means.

115. Apparatus according to claim 114 wherein at least one of said at least one sheet carries inlet means and/or outlet means.

116. Apparatus according to claim 109 wherein the control means is further adapted to cause the outlet means to open to substantially maintain the pressure within the chamber at ambient pressure.

117. Apparatus for adjusting the atmosphere within a chamber comprising:

(a) sealing means for substantially sealing the chamber;

(b) inlet means to permit ambient atmosphere to enter the chamber;

(c) outlet means to permit chamber atmosphere to exit the chamber;

(d) a controller having an oxygen concentration sensor and control means responsive to the oxygen concentration sensor, the control means being adapted to cause the inlet means to open to admit ambient atmosphere into the chamber following the oxygen concentration sensor detecting that the oxygen concentration in the chamber has fallen below a predetermined amount; and

(e) carbon dioxide reduction means adapted to remove carbon dioxide from the chamber atmosphere substantially at a predetermined rate so that, in use, the

carbon dioxide concentration within the chamber atmosphere will not substantially exceed a predetermined amount when the chamber contains respiring produce.

~~118. Apparatus according to claim 117 wherein said carbon dioxide reduction means is a carbon dioxide absorbing material.~~

119. Apparatus according to claim 118 wherein said carbon dioxide absorbing material is contained in at least one carbon dioxide transmissible container.

sub a45 ~~120. Apparatus according to claim 119 wherein said at least one carbon dioxide transmissible container is selected so that the rate of carbon dioxide transmission into said at least one carbon dioxide transmissible container is substantially equal to said predetermined carbon dioxide removal rate.~~

~~121. Apparatus according to claim 117 wherein the control means is further adapted to cause the outlet means to open to substantially maintain the pressure within the chamber at ambient pressure.~~

122. Apparatus according to claim 117 wherein said controller is further adapted to cause the inlet means to remain open for a time that is approximately proportional to the difference between the detected oxygen concentration and an oxygen setpoint.

123. Apparatus according to claim 120 wherein said controller is further adapted to cause the inlet means to remain open for a time that is approximately proportional to the difference between the detected oxygen concentration and an oxygen setpoint.

124. Apparatus according to claim 122 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded a predetermined value.

125. Apparatus according to claim 123 wherein said controller is so adapted that if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following

detection that the oxygen concentration in the chamber has exceeded a predetermined value.

126. Apparatus according to claim 124 wherein said controller is so adapted that:

(a) if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint; and

(b) if the difference between the detected oxygen concentration and the oxygen setpoint does not exceed said predetermined amount in paragraph (a) then the inlet means remains open for a time that depends on which of a number of predetermined ranges the said difference falls within such that the greater the average value of the range, the greater the time for which the inlet means remains open.

127. Apparatus according to claim 125 wherein said controller is so adapted that:

(a) if the difference between the detected oxygen concentration and the oxygen setpoint exceeds a predetermined amount, the inlet means remains open until following detection that the oxygen concentration in the chamber has exceeded the oxygen setpoint; and

(b) if the difference between the detected oxygen concentration and the oxygen setpoint does not exceed said predetermined amount in paragraph (a) then the inlet means remains open for a time that depends on which of a number of predetermined ranges the said difference falls within such that the greater the average value of the range, the greater the time for which the inlet means remains open.

128. Apparatus according to claim 117 wherein said sealing means includes a substantially fluid impervious sheet for separating the chamber from leakage paths associated with the door.

129. Apparatus according to claim 117 wherein said sealing means includes at least one flexible substantially fluid impervious sheet carrying inlet means and/or outlet means.

130. Apparatus according to claim 128 wherein at least one of said at least one sheet carries inlet means and/or outlet means.

131. Apparatus according to claim 117 wherein the control means is further adapted to cause the outlet means to open to substantially maintain the pressure within the chamber at ambient pressure.

Sub a5> 132. Apparatus for adjusting the atmosphere within a chamber comprising:

(a) sealing means for substantially sealing the chamber;

(b) inlet means to permit ambient atmosphere to enter the chamber;

(c) outlet means to permit chamber atmosphere to exit the chamber; and

(d) a controller having an oxygen concentration sensor and control means responsive to the oxygen concentration sensor, the control means being adapted to cause the inlet means to open to admit ambient atmosphere into the chamber following the oxygen concentration sensor detecting that the oxygen concentration in the chamber has fallen below a predetermined amount;

wherein said inlet means and/or outlet means comprise one or more electromagnetically actuable valves having a solenoid so that said one or more valves may be opened from a closed position and closed from an open position by applying direct electric current to the solenoid, said one or more valves being held in either the open position or the closed position in the absence of the application of said direct electric current.

133. Apparatus according to claim 132 wherein said one or more valves may be both opened from a closed position and closed from an open position by applying a pulse of direct electric current to the solenoid.

134. Apparatus according to claim 131 wherein said at least one valve is adapted to be held in the closed position or the open position in the absence of an electric current in the solenoid by magnetic forces.

135. Apparatus according to claim 133 wherein said at least one valve is adapted to be held in the closed position or the open position in the absence of an electric current in the solenoid by magnetic forces.

136. Apparatus according to claim 132 wherein said one or more valves comprises a bore, a member moveable within the bore, at least one sealing surface associated with the member, at least one aperture through which fluid may pass to pass through the valve, a solenoid adapted to generate a magnetic field in the bore in response to the application of a direct electric current, the member being adapted to move with respect to the bore in response to said magnetic field between a valve open position wherein fluid passes through said at least one aperture and a valve closed position wherein said at least one sealing surface prevents fluid passing through each said at least one aperture.

137. Apparatus according to claim 136 wherein the member is a slidable within the bore.

138. Apparatus according to claim 137 wherein the slidable member carries at least one cover adapted to cover each said at least one aperture to prevent fluid passing through said at least one aperture.

139. Apparatus according to claim 132 wherein said one or more valves comprises at least one aperture through which fluid may pass to pass through the valve, a solenoid to generate a magnetic field in response to the application of a direct electric current and a flap which is adapted to move in response to said magnetic field between a valve open position wherein fluid may pass through the valve through said at least one aperture and a valve closed position wherein the flap prevents fluid passing through the valve through any said at least one aperture.

140. Apparatus according to claim 139 wherein the solenoid is located between the flap and a member carried by the flap, the member and the flap each having a permanent magnet so arranged that when a direct electric current is passed through the valve in one direction the solenoid attracts the magnet on the member and repulses the magnet on the flap in order to move the flap to a valve open position and when a direct electric current is passed through the solenoid in a direction opposite to said one direction the solenoid repulses the magnet on the member and attracts the magnet on the flap in order to move the flap to a valve closed position.

141. Apparatus according to claim 140 wherein an armature is provided in the solenoid, the flap may held in the valve open position in the absence of an electric current in the solenoid by the magnetic attraction between the armature and the magnet on the member, and the flap may held in the valve closed position in the absence of an electric current in the solenoid by the magnetic attraction between the armature and the magnet on the flap.

142. Apparatus according to claim 132 wherein the control means is further adapted to cause the outlet means to open to substantially maintain the pressure within the chamber at ambient pressure.

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143. A method for adjusting the atmosphere within a chamber containing respiring produce, the method comprising:

(a) flushing the chamber with a purging gas;

(b) adjusting the oxygen level in the chamber to a level above a desired oxygen setpoint;

(c) permitting the oxygen level in the chamber to degrade to about the oxygen setpoint as a consequence of oxygen consumed by the produce being converted to carbon dioxide;

(d) removing chamber atmosphere from the chamber; and

(e) repeating steps (b), (c) and (d) as required if the oxygen level falls below the oxygen setpoint, to maintain the oxygen level in the region of the oxygen setpoint.

144. A method according to claim 143, wherein said purging gas has a low oxygen concentration or no oxygen.

145. A method according to claim 143, and further comprising the step of placing a carbon dioxide absorbing material in the chamber so as to absorb the difference between a predicted level of carbon dioxide in the chamber based on the rate of consumption of oxygen by the produce and a desired carbon dioxide level so that the carbon dioxide concentration in the chamber does not substantially exceed said desired level.

sub a1>

~~146. A method according to claim 145 wherein the rate of removal of carbon dioxide from the chamber is calculated from a formula that produces a result substantially equal to the result produced by a calculation in accordance with the following formula:~~

$$a_{CO_2} = r_{CO_2} - \frac{0.79 p_{CO_2} r_{O_2}}{\left(0.21 - p_{O_2}\right) - 0.21 p_{CO_2}}$$

~~where a_{O_2} is the carbon dioxide removal rate; p_{O_2} is the oxygen setpoint, expressed as a proportion; p_{CO_2} is the desired carbon dioxide concentration within the chamber, expressed as a proportion; r_{O_2} is the respiration rate; and r_{CO_2} is the rate of production of carbon dioxide through respiration.~~

147. A method for adjusting the level of carbon dioxide in a chamber containing respiring produce, the method comprising the step of placing a carbon dioxide absorbing material in the chamber so as to absorb the difference between a predicted level of carbon dioxide in the chamber based on the rate of consumption of oxygen by the produce and a desired carbon dioxide level so that the carbon dioxide concentration in the chamber does not substantially exceed said desired level.

148. A method according to claim 147 wherein the rate of removal of carbon dioxide from the chamber is calculated from a formula that produces a result substantially equal to the result produced by a calculation in accordance with the following formula:

$$a_{CO_2} = r_{CO_2} - \frac{0.79 p_{CO_2} r_{O_2}}{\left(0.21 - p_{O_2}\right) - 0.21 p_{CO_2}}$$

where a_{O_2} is the carbon dioxide removal rate; p_{O_2} is the oxygen setpoint, expressed as a proportion; p_{CO_2} is the desired carbon dioxide concentration within the chamber, expressed as a proportion; r_{O_2} is the respiration rate; and r_{CO_2} is the rate of production of carbon dioxide through respiration.

149. A method according to claim 1 wherein at least part of said carbon dioxide removal is effected by chamber atmosphere exiting the chamber through the outlet means.

150. A method for adjusting the atmosphere within a substantially sealed chamber containing respiring produce, the chamber having inlet means to permit ambient atmosphere to enter the chamber, and outlet means to permit chamber atmosphere to exit the chamber, the method comprising:

(a) monitoring the oxygen concentration within the chamber;

(b) following detection that the oxygen concentration in the chamber has fallen below a predetermined amount, opening the inlet means to permit ambient atmosphere to enter the chamber so that the amount of oxygen in the chamber increases;

(c) opening the outlet means to substantially maintain the pressure within the chamber at ambient pressure; and

(d) selecting an oxygen setpoint such that steps (a), (b) and (c) cause the carbon dioxide concentration within the chamber atmosphere to not substantially exceed a predetermined amount.

151. A method according to claim 150 wherein said oxygen setpoint is calculated from a formula derived from a mathematical model of the proportions of the chamber atmosphere subject to the requirement that the oxygen concentration within the chamber be substantially maintained at a predetermined amount.

152. A method according to claim 151 wherein said oxygen setpoint is calculated from a formula that produces a result substantially equal to the result produced by a calculation in accordance with the following formula:

$$p_{O_2} = 0.21 - p_{CO_2}(0.79 + 0.21RQ)$$

where p_{O_2} is the oxygen setpoint, expressed as a proportion; p_{CO_2} is the desired carbon dioxide concentration within the chamber, expressed as a proportion; and RQ is the respiration quotient.

add B1>